

**FINAL
FIELD SAMPLING PLAN FOR
AREA 3

OF THE
CAMP EDWARDS IMPACT AREA
GROUNDWATER QUALITY STUDY

MASSACHUSETTS MILITARY RESERVATION
CAPE COD, MASSACHUSETTS**

**Prepared for

NATIONAL GUARD BUREAU
ARLINGTON, VIRGINIA**

**Prepared by

OGDEN ENVIRONMENTAL AND ENERGY SERVICES
239 Littleton Road, Suite 1B
Westford, Massachusetts 01886**



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Final FSP Area 3

DISCLAIMER:

This document has been prepared pursuant to a government administrative order (U.S. EPA Region I SDWA Docket No. I-97-1019) and is subject to approval by the U.S. Environmental Protection Agency. The opinions, findings, and conclusions expressed are those of the authors and not necessarily those of the Environmental Protection Agency.

Final FSP Area 3

A.1 Area 3 Field Sampling Plan

A.1.1 Background and Focal Area(s)

Area 3 is located near the intersection of Turpentine Road and Tank Alley, as indicated in Figure A.1-1. A circular cleared area was located northeast of this intersection in aerial photographs from 1951 to 1971. Burning may have occurred at this area based on the appearance of multi-toned, darker soils in the aerial photograph. A pit appears to be located east of the cleared area in the 1951 aerial photograph, and is still visible today. This pit is 60x30 feet and is approximately 15 feet deep. The pit is completely revegetated with trees and shrubs. Artillery and mortar targets were located along both of these roadways, including tanks along Tank Alley and an armored personnel carrier along Turpentine Road. A 1991 infrared aerial photograph shows the heaviest disturbance to vegetation along Turpentine Road north of the intersection, and along Tank Alley east of the intersection. Historical accounts of interviewees indicate that the heaviest bombardment was along Turpentine Road near this intersection.

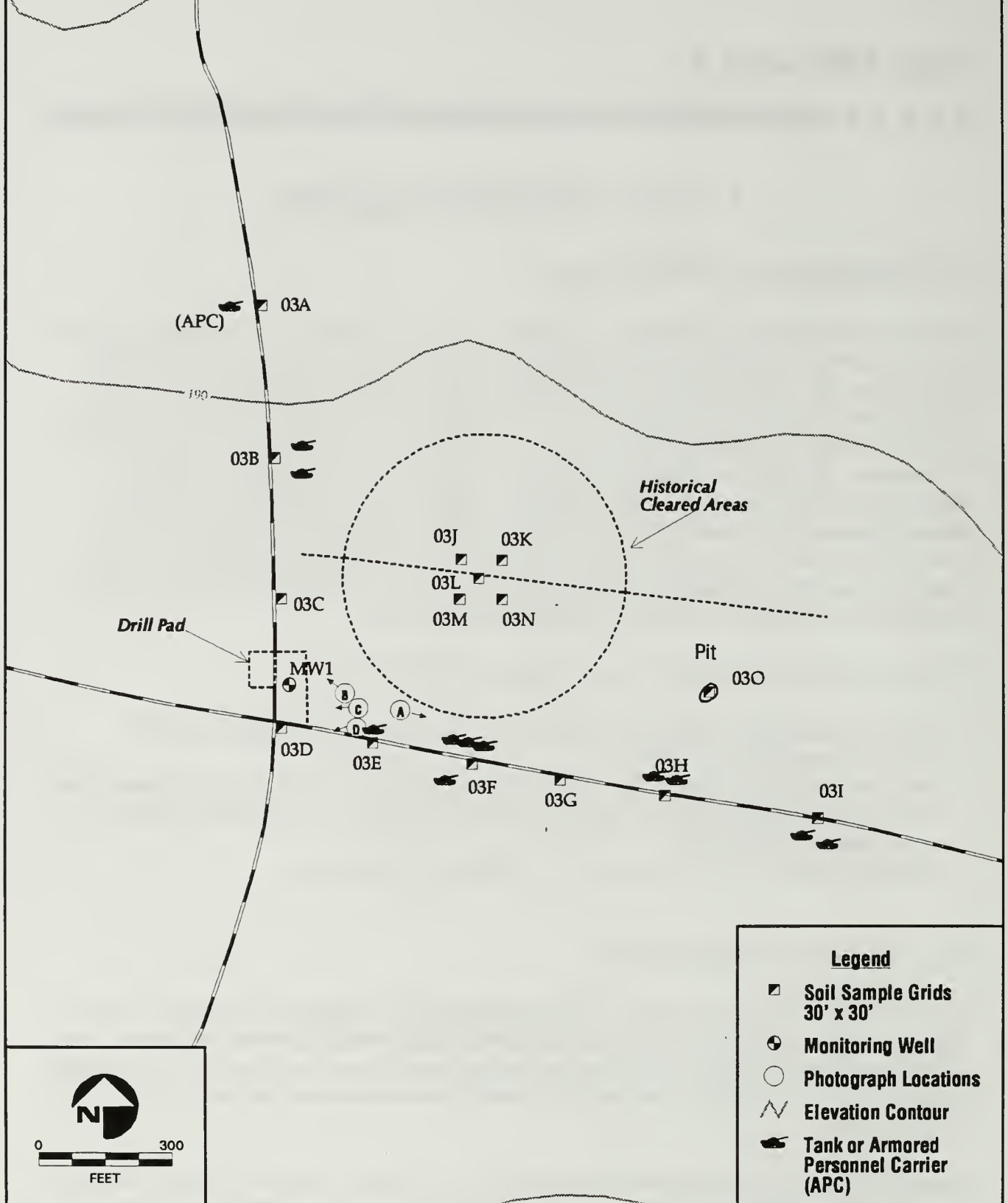
Three focal areas are identified for Area 3, as indicated in Figure A.1-1:

- the 600-foot diameter former cleared area depicted in the aerial photographs, with an estimated area of 6.5 acres; and
- the target areas along Turpentine Road (extending 900 feet from Tank Alley to the north) and Tank Alley (extending 1200 feet from Turpentine to the east), with an estimated area of 1.5 acres based on 30 feet wide.
- the 60x30 foot pit, 215' north of Tank Alley, 950' east of Turpentine

A.1.2 Sampling & Analysis Methods

Area 3 sampling will include surface soil at each focal area based on the potential release of, munitions-related contaminants at ground surface from target practice or waste management. Area 3 sampling will also include subsurface soil and groundwater at the roadway/targets focal area based on the reported heavy use of this area and the potential for contaminants to migrate into deeper soils or groundwater.

Sample collection will be consistent with MMR SOPs, the Ogden Health and Safety Guidelines, Appendix A: Field Guide to High Explosives, and the EPA Standard Guide for Composite Sampling



FIGURE

Area 3 Sampling Points

A.1-1

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and Field Subsampling for Environmental Waste Management Activities (October 31, 1996). Area 3 is within the Impact Area, therefore all soil samples with detectable levels of explosives by the colorimetric analysis will be analyzed by EPA Method 8330. **All borings and hand auger locations in Area 3 are subject to UXO clearance requirements.**

Hand Augering Grids

A representative portion of each focal area will be sampled, as indicated in Figure A.1-1. For the roadway/targets focal area, nine sampling grids will be located at intervals of 200-300 feet. The roadway grids will be near the proposed locations in Figure A.1-1, which are immediately adjacent to visible targets or in the area of the most extensive cratering. Three grids (03A through 03C) will be placed along Turpentine Road and six grids (03D through 03I) will be placed along Tank Alley. For the historic cleared focal area a representative portion consisting of a 1-acre location at the center will be sampled with 5 grids (03J through 03N). Sampling at the center will provide the highest probability that sampling occurs within the focal area, since there is no longer any evidence of a clearing at this location. The cleared area location has been plotted on Figure A.1-1 based on scaling from the aerial photographs The circular cleared area grids will be located by land survey or by tape measuring off of roadways. One grid, 03O, will be placed in the 60x30 foot pit north of Tank Alley.

Each soil boring grid will consist of nine sample points spaced ten feet apart. The following protocol will be followed for hand augering:

1. A 0-6" soil sample will be collected from each of the nine sample points in a grid;
2. soil from each sample point will be placed in a headspace jar;
3. the remaining soil from each of the nine sample points will be composited in accordance with Section 8.1 of the EPA Standard Guide and Attachment A of this FSP;
4. headspace measurements will be collected from each of the nine 0-6" samples and recorded in the space provided on the hand auger log;
5. a VOC grab sample will be collected from one sample point based on the following priority of observations: 1) highest response on the FID, 2) visual signs of contamination, 3) the central grid location (a fresh soil sample will be collected adjacent to the sample point);
6. the composite sample will be submitted for explosives, inorganics, and other analytes;
7. when the analytical results from the 0-6" sample are available, an 18-24" sample will be collected and composited as described above for explosives, inorganics, and any other analytes (except VOC) that are detected in the 0-6" sample;

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8. an 18-24" sample will be selected for VOC analysis based on screening with an FID as described in steps 1-5 above.

Barber Rig Drilling

A boring will be advanced to bedrock at the location indicated in Figure A.1-1, and completed as a nested shallow and deep monitoring well. This boring will be completed using a Barber Rig. This well nest is Monitoring Well #1. An intermediate depth well will be completed in an adjacent boring based on the VOC and explosives screening of groundwater for the initial boring. The borings will be placed at the southwest corner of the 75-foot by 150-foot area adjacent to Turpentine Road and Tank Alley.

Prior to the onset of the investigation, the site will be intrusively cleared of UXO to a depth of two feet below grade. Additional clearance will occur from a depth of two feet to ten feet below grade.

A down-hole magnetometer will be lowered into the hole prior to advancing the auger in two-foot intervals. After completion of the next two-foot interval, 4" PVC will be inserted into the borehole and the rig will be moved off of the hole prior to magnetic survey of the next interval. The boring location will be considered clear when a depth of ten feet is reached without encountering any magnetic anomalies.

The following protocol will be followed while drilling with a barber rig in the Impact Area:

1. A 0-6" sample will be collected and submitted for explosives, inorganics, and all other analytes;
2. From ten feet below grade until the water table is encountered, a soil sample will be collected every ten feet using a split spoon;
3. The 10-12' interval will be FID screened and submitted for explosives, inorganics, and other analytes;
4. The 20-22' interval will be FID screened and submitted for explosives, and inorganics;
5. Each sample below the 20-22' interval will be screened with an FID and sampled for explosives (submitted ON HOLD) and inorganic analysis;
6. The soil samples submitted ON HOLD for explosives will be analyzed only if explosives are detected in the 10-12' or 20-22' sample interval; and
7. Each sample below the 20-22' interval will be sampled for the other analytes only if there is a response on the FID.

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8. Based on the results of the 0-6" sample, an 18-24" grab sample may be collected with a hand auger and submitted for explosives, inorganics, and other analytes as directed by the Field Manager.
9. The boring will be advanced 15 feet from refusal to confirm that bedrock has been encountered.

From the water table to the completion of the boring, soil will be sampled from the cyclone for lithology. Groundwater samples will be collected at every ten feet during advancement of the borings and will be submitted for laboratory analysis of explosives and VOCs. Wells will be screened as described in Section 4.2.2 of the Action Plan.

Table A.1-1 lists sample numbers and analytical requirements for the areas to be investigated.

Table A.1-1: Samples to Be Collected from Area 3

MMR Soil Samples from Hand Auger Grids					Parameters:	Explosives (colorimetric)	Explosives (EPA 8330)	Inorganics	Other Analytes:	VOC	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
Area	Grid	Depth	MMR ID	EPA/Ogden ID	Cont.	8oz	8oz	8oz		4oz		8 oz			4oz
X = to be collected and submitted to laboratory															
# = to be collected after results from the 0-6" sample are received															
3A	03A	0-6	71BS03AXAX01XA	B03AAA	grab					X					
			71BS03AXAX01XA	B03AAA	comp	X		X			X	X	X	X	X
		18-24	71BS03AXBX01XA	B03ABA	grab					#					
			71BS03AXBX01XA	B03ABA	comp	#		#			#	#	#	#	#
	03B	0-6	71BS03BXAX01XA	B03BAA	grab					X					
			71BS03BXAX01XA	B03BAA	comp	X		X			X	X	X	X	X
		18-24	71BS03BXXB01XA	B03BBA	grab					#					
			71BS03BXXB01XA	B03BBA	comp	#		#			#	#	#	#	#
	03C	0-6	71BS03CXAX01XA	B03CAA	grab					X					
			71BS03CXAX01XA	B03CAA	comp	X		X			X	X	X	X	X
		18-24	71BS03CXXB01XA	B03CBA	grab					#					
			71BS03CXXB01XA	B03CBA	comp	#		#			#	#	#	#	#
	03D	0-6	71BS03DXAX01XA	B03DAA	grab					X					
			71BS03DXAX01XA	B03DAA	comp	X		X			X	X	X	X	X
		18-24	71BS03DXXB01XA	B03DBA	grab					#					
			71BS03DXXB01XA	B03DBA	comp	#		#			#	#	#	#	#
	03E	0-6	71BS03EXAX01XA	B03EAA	grab					X					
			71BS03EXAX01XA	B03EAA	comp	X		X			X	X	X	X	X
		18-24	71BS03EXBX01XA	B03EBA	grab					#					
			71BS03EXBX01XA	B03EBA	comp	#		#			#	#	#	#	#
	03F	0-6	71BS03FXAX01XA	B03FAA	grab					X					
			71BS03FXAX01XA	B03FAA	comp	X		X			X	X	X	X	X
		18-24	71BS03FXBX01XA	B03FBA	grab					#					
			71BS03FXBX01XA	B03FBA	comp	#		#			#	#	#	#	#
	03G	0-6	71BS03GXAX01XA	B03GAA	grab					X					
			71BS03GXAX01XA	B03GAA	comp	X		X			X	X	X	X	X
		18-24	71BS03GXBX01XA	B03GBA	grab					#					
			71BS03GXBX01XA	B03GBA	comp	#		#			#	#	#	#	#
	03H	0-6	71BS03HXAX01XA	B03HAA	grab					X					
			71BS03HXAX01XA	B03HAA	comp	X		X			X	X	X	X	X
		18-24	71BS03HXXB01XA	B03HBA	grab					#					
			71BS03HXXB01XA	B03HBA	comp	#		#			#	#	#	#	#
	03I	0-6	71BS03IXAX01XA	B03IAA	grab					X					
			71BS03IXAX01XA	B03IAA	comp	X		X			X	X	X	X	X
		18-24	71BS03IXBX01XA	B03IBA	grab					#					
			71BS03IXBX01XA	B03IBA	comp	#		#			#	#	#	#	#

Table A.1-1: Samples to Be Collected from Area 3

MMR Soil Samples from Hand Auger Grids					Parameters:	Explosives (colorimetric)	Explosives (EPA 8330)	Inorganics	Other Analytes:	VOC	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
Area	Grid	Depth	MMR ID	EPA/Ogden ID	Cont.	8oz	8oz	8oz		4oz		8 oz			
X = to be collected and submitted to laboratory															
# = to be collected after results from the 0-6" sample are received															
	03J	0-6	71BS03JXAX01XA	B03JAA	grab					X					
			71BS03JXAX01XA	B03JAA	comp	X		X			X	X	X	X	X
		18-24	71BS03JXBX01XA	B03JBA	grab					#					
			71BS03JXBX01XA	B03JBA	comp	#		#			#	#	#	#	#
	03K	0-6	71BS03KXAX01XA	B03KAA	grab					X					
			71BS03KXAX01XA	B03KAA	comp	X		X			X	X	X	X	X
		18-24	71BS03KXBX01XA	B03KBA	grab					#					
			71BS03KXBX01XA	B03KBA	comp	#		#			#	#	#	#	#
	03L	0-6	71BS03LXAX01XA	B03LAA	grab					X					
			71BS03LXAX01XA	B03LAA	comp	X		X			X	X	X	X	X
		18-24	71BS03LXBX01XA	B03LBA	grab					#					
			71BS03LXBX01XA	B03LBA	comp	#		#			#	#	#	#	#
	03M	0-6	71BS03MXAX01XA	B03MAA	grab					X					
			71BS03MXAX01XA	B03MAA	comp	X		X			X	X	X	X	X
		18-24	71BS03MXBX01XA	B03MBA	grab					#					
			71BS03MXBX01XA	B03MBA	comp	#		#			#	#	#	#	#
	03N	0-6	71BS03NXAX01XA	B03NAA	grab					X					
			71BS03NXAX01XA	B03NAA	comp	X		X			X	X	X	X	X
		18-24	71BS03NXBX01XA	B03NBA	grab					#					
			71BS03NXBX01XA	B03NBA	comp	#		#			#	#	#	#	#
	03O	0-6	71BS03OXAX01XA	B03OAA	grab					X					
			71BS03OXAX01XA	B03OAA	comp	X		X			X	X	X	X	X
		18-24	71BS03OXB01XA	B03OBA	grab					#					
			71BS03OXB01XA	B03OBA	comp	#		#			#	#	#	#	#

Table A.1-1: Samples to Be Collected from Area 3

MMR Subsurface Soil Samples from Borings					Parameters:	Explosives (colorimetric)	Explosives (EPA 8330)	Inorganics	Other Analytes:	VOC	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
Area	Loc.	Depth	MMR ID	EPA/Ogden ID	Cont.	8oz	8oz	8oz		4oz		8 oz			4oz
X - collect and submit															
@ - to be collected after results from the 0-6" sample are received															
X - collect and submit ON HOLD															
* - collect and submitted only if there is an FID response.															
3	MW1	A(0-6")	71MS01DXAX01XA	S01DAA		X		X		X	X	X	X	X	X
		B(18-24")	71MS01DXBX01XA	S01DBA		@		@		@	@	@	@	@	@
		C(10-12')	71MS01DXCX01XA	S01DCA		X		X		X	X	X	X	X	X
		D(20-22')	71MS01DXDX01XA	S01DDA		X		X		*	*	*	*	*	*
		E	71MS01DXEX01XA	S01DEA		X		X		*	*	*	*	*	*
		F	71MS01DXFX01XA	S01DFA		X		X		*	*	*	*	*	*
		G	71MS01DXGX01XA	S01DGA		X		X		*	*	*	*	*	*
		H	71MS01DXHX01XA	S01DHA		X		X		*	*	*	*	*	*
		I	71MS01DXIX01XA	S01DIA		X		X		*	*	*	*	*	*
		J	71MS01DXJX01XA	S01DJA		X		X		*	*	*	*	*	*
		K	71MS01DXKX01XA	S01DKA		X		X		*	*	*	*	*	*
		L	71MS01DXLX01XA	S01DLA		X		X		*	*	*	*	*	*
		M	71MS01DXMX01XA	S01DMA		X		X		*	*	*	*	*	*

MMR Groundwater Samples from Borings					Parameters:	Explosives (8330 screen)	Explosives (EPA 8330)	Inorganics	Other Analytes:	VOC	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
Area	Loc.	Depth	MMR ID	EPA/Ogden ID	Cont:	250ml	2*1L			3*40mL	2*1Lg	2*1Lg	2*1Lg	3*40mL	3*40mL
					Pres:	non	non			HCl	non	non	non	HCl	thio
3	MW1	A	71GB01DXAX01XA	G01DAA		X				X					
		B	71GB01DXBX01XA	G01DBA		X				X					
		C	71GB01DXCX01XA	G01DCA		X				X					
		D	71GB01DXDX01XA	G01DDA		X				X					
		E	71GB01DXEX01XA	G01DEA		X				X					
		F	71GB01DXFX01XA	G01DFA		X				X					
		G	71GB01DXGX01XA	G01DGA		X				X					
		H	71GB01DXHX01XA	G01DHA		X				X					
		I	71GB01DXIX01XA	G01DIA		X				X					
		J	71GB01DXJX01XA	G01DJA		X				X					
		K	71GB01DXKX01XA	G01DKA		X				X					
		L	71GB01DXLX01XA	G01DLA		X				X					
		M	71GB01DXMX01XA	G01DMA		X				X					
		N	71GB01DXNX01XA	G01DNA		X				X					
		O	71GB01DXOX01XA	G01DOA		X				X					

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Photograph A: Looking east along Tank Alley from a point north of Tank Alley.



Photograph B: Looking northwest toward Turpentine Road from a point north of Tank Alley.

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Photograph C: Looking west along Tank Alley from north of Tank Alley



Photograph D: Looking southwest from a point north of Tank Alley.

ATTACHMENT A: FIELD GUIDE TO HIGH EXPLOSIVES

Any substance encountered during sampling activities which differs in any way from natural media will be treated as a dangerous substance, carefully removed from the sample, and set aside.

EXPLOSIVES

<u>NAME</u>	<u>DESCRIPTION</u>	<u>REMARKS</u>
BLACK POWDER	BROWN TO BLACK	MANUFACTURED IN GRAINS THAT RANGE IN SIZE FROM SMALLER THAN SALT GRAINS TO GRAINS AS LARGE AS SMALL PEBBLES. HIGHLY SENSITIVE TO IGNITION BY HEAT, FRICTION, FLAME, SPARK. WHEN WET, IT IS CORROSIVE TO MOST METALS.
TNT	LIGHT YELLOW TO BROWN OR GRAY	LIGHTLY CORROSIVE WITH LEAD. USED IN BOMBS, GRENADES, DEMOLITION CHARGES, PROJECTILES. EXUDES AT ELEVATED TEMPERATURES. MODERATELY TOXIC BY SKIN ABSORPTION OR INHALATION.
EXPLOSIVE D	BRIGHT YELLOW TO ORANGE. ALSO CALLED AMMONIUM PICRATE.	RELATIVELY INSENSITIVE. HIGHLY TOXIC BY INHALATION, INGESTION, OR SKIN ABSORPTION
AMATOL	LIGHT BROWN TO YELLOW/MIXTURE OF TNT AND EXPLOSIVE D	SLIGHT HYGROSCOPIC. HAS CORROSIVE EFFECTS ON COPPER, BRONZE, LEAD, BRASS. HIGHLY TOXIC BY INHALATION, SKIN CONTACT, INGESTION.
COMPOSITION B	WHITE TO BROWNISH YELLOW, MIXTURE OF TNT AND EXPLOSIVE D	SLIGHTLY CORRODES COPPER, BRASS, CADMIUM, ZINC. USED IN BOMBS, PROJECTILES, GRENADES, SHAPED CHARGES.
OCTOL	LIGHT BROWN	USED IN BOMBS, PROJECTILES, SHAPED CHARGES.
RDX	WHITE. ALSO CALLED CYCLONITE	SENSITIVE TO IMPACT AND FRICTION. SLIGHTLY CORROSIVE WITH COPPER, BRASS, MILD STEEL, CADMIUM. MODERATELY TOXIC BY INHALATION OR INGESTION.
HMX	WHITE. ALSO CALLED OCTOGEN	SENSITIVE TO IMPACT AND FRICTION. SLIGHTLY TOXIC.
PETN	WHITE	SENSITIVE TO IMPACT. SLIGHTLY CORROSIVE TO BRASS, CADMIUM, ZINC. VERY SLIGHTLY TOXIC.

EXPLOSIVES, continued

<u>NAME</u>	<u>DESCRIPTION</u>	<u>REMARKS</u>
LEAD AZIDE	WHITE TO LIGHT BROWN	VERY SENSITIVE TO IMPACT, FRICTION, SPARKS. CORROSIVE TO COPPER, ZINC. VERY SLIGHTLY TOXIC.
LEAD STYPHNATE	LIGHT ORANGE TO REDDISH BROWN	SAME AS LEAD AZIDE.
MERCURY FULMINATE	GRAYISH	VERY SENSITIVE TO IMPACT, FRICTION, SPARKS. CORROSIVE TO ALUMINUM, MAGNESIUM, COPPER, BRONZE, COPPER, ZINC, BRASS. HIGHLY TOXIC THROUGH SKIN ABSORPTION, INHALATION, INGESTION. SYMPTOMS RESEMBLE MERCURY POISONING.

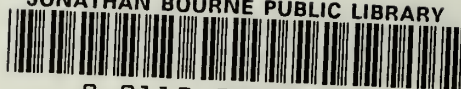
PYROTECHNIC AGENTS USED AT MMR

<u>SYMBOL</u>	<u>COMMON NAME</u>	<u>VISUAL IDENTIFICATION</u>	<u>ACTION</u>
CS	NONE	WHITE CRYSTALLINE SOLID	TEAR AGENT
HC	HEXACHORO-ETHANE	WHITE SOLID	SCREENING SMOKE
WP	WHITE PHOSPHOROUS	PALE YELLOW SOLID	SCREEN SMOKE AND INCENDIARY
RP	RED PHOSPHOROUS	REDDISH BROWN POWDER	SCREENING SMOKE

OTHER COMPOUNDS

<u>NAME</u>	<u>PROPERTIES</u>	<u>STABILITY</u>
Picric Acid	lemon-yellow crystalline solid	very sensitive to blows or friction
Tetryl	fine yellow crystalline powder	sensitive to blows or friction
Composition A	unknown	unknown
Composition C3	unknown	unknown
Composition C4	unknown	unknown
Pentolite (50/50)	unknown	unknown
Tracer Compound	unknown	unknown
PBX	unknown	unknown
Ednatol	unknown	unknown
Tetrytol	unknown	unknown

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